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(54) BONDED SHEETS FOR PACKING

(71) We, MOPLEFAN S.p.A., an Italian Company of 31 Foro Buonaparte, Milan, Italy, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The invention relates to bonded sheets for packing, that is for containers, envelopes, bags, and cans, for foodstuffs for example.

The invention provides a bonded sheet comprising A a film oriented by stretching of polypropylene consisting essentially of isotactic macromolecules, having a melt index of from 0.5 to 5, and B a film prepared from polyethylene, isotactic polypropylene, a propylene-ethylene crystalline copolymer container predominantly propylene of the block or the random type, a mixture of polyethylene with polypropylene or with a propylene-ethylene copolymer or a mixture of polypropylene with a propylene-ethylene copolymer, at least one of the two films having, on its surface in contact with the other film, a metallized coating with a resistivity of from 1 to 5 Ohm.

These sheets generally have an overall thickness of from 20 to 200 microns, each film preferably from 10 to 100 microns. An adhesive may be interposed between the films. The film B may optionally be oriented by stretching. If oriented films are employed, it is advisable to coat one of the films with a thermowelding layer.

Metalization is preferably carried out under vacuum using aluminium (the most economical), zinc, gold, palladium, or cadmium.

The films are optionally subjected to a continuous, not-perforating electric discharge. The polypropylene of film B preferably has a melt index of from 5 to 20, the polyethylene of from 0.5 to 15, the ethylene-propylene copolymers from 3 to 20. The ethylene content of the copolymers is preferably from 0.1 to 15%. All % herein are by weight except where the sense demands otherwise. In the mixtures, polyethylene and copolymers are preferably employed at the rate of from 1 to 50% based on the total.

The bonded sheets of the invention are generally prepared by lamination of the two films with each other, either with or without on interposed adhesive, by causing them to pass between rollers heated to from 30 to 90°C. The bonding of the films without interposed adhesive, and/or the coating of the films with a thermowelding layer, that may consist of polyethylene, or ethylene-propylene crystalline copolymer or a mixture of polyethylene and said copolymers, can be carried out by extrusion coating.

An adhesive can be applied onto one film face, by spreading, starting from a solution or dispersion in water or an organic solvent. Generally, a solution having an adhesive concentration of from 5 to 40% is employed, in order to have an amount of adhesive on the film of from 1 to 10 g/m^2 of surface. Adhesives which have proved particularly suitable include thermoplastic resins, such as cellulose esters and ethers, alkyl and acrylic esters, polyamides, polyurethanes, polyesters, thermosetting resins, such as epoxy resins, urea/formaldehyde, phenol/formaldehyde, melamine/formaldehyde resins, and synthetic rubbers. As solvents for the adhesive, hydrocarbons, such as ligroin and toluene, esters, such as ethyl acetate, and ketones, such as acetone and methyl ethyl ketone can be used.

The olefin polymeric films to be bonded according to the invention can be prepared from olefin polymers to which additives, for example opacifiers, stabilizers, lubricants, fillers, organic and inorganic pigments, may be added prior to film formation. The films to be bonded may be subjected to a superficial pretreatment with a continuous, not-perforating

electric discharge, or with a chemical agent, in order to increase their adhesive receptivity, and may be lacquered in order to improve their thermoweldability.

The transmittance measurements on the sheets mentioned below have been carried out by spectrophotometry. The permeability to water vapour has been evaluated according to ASTM-E-96, that to the other gases according to ASTM-D-1434, both at 25°C. The melt index has been determined according to ASTM-D-1238-65T. The resistance of the weld has been measured according to the peeling strength test method, evaluating the tensile strength of the weld by means of a dynamometer (for example an Instron dynamometer). The resistance to perforation has been measured by means of a dynamometer of the Instron type, using a punch having a diameter of 1.4 mm and a union of 0.7 mm.

The following Examples illustrate the invention:

Example 1

A bonded sheet was prepared by conveying between rollers heated to 70°C:

A a polypropylene film bioriented by stretching in the longitudinal and transverse directions, having been treated with continuous, not-perforating electric discharge and metallized under vacuum on one face with aluminium (surface resistivity = 3 Ohm), having the following characteristics:

thickness	25 microns
longitudinal tensile strength	13 kg/mm^2
transverse tensile strength	28 kg/mm^2
longitudinal elongation	180 %
transverse elongation	45%
resistance to tearing (Elmendorf)	11 g/25 microns.

The polypropylene employed for filming was a polymer having prevailingly isotactic macromolecules, prepared by means of stereospecific catalysts, having a melt index of 4, a residue after extraction with heptane of 96.5%, and an ash content of 75 ppm (parts per million). The metallized face of the film was coated with a polyurethane-based adhesive in an amount of 1.5 g/m^2 of surface and contacted with the other film;

B an unoriented film of 25 microns thickness treated with continuous, not-perforating electric discharge, prepared from polypropylene having a melt index of 10, a residue after extraction with heptane of 96.5%, an ash content of 75 ppm.

The resulting bonded sheet had the following characteristics:

thickness	52 microns
transmittance	1 %
permeability:	
to oxygen	35 cm^3/m^2.24 h.kg/cm^2
to carbon dioxide	150 cm^3/m^2.24 h.kg/cm^2
to water vapour	1 g/m^2.24 h
weldability range	150 - 170°C
resistance of the weld	700 g/cm
resistance to perforation	1300 g

Example 2

A bonded sheet was prepared as in Example 1, except that film B was replaced by an unoriented, 25-micron thick film, subjected prior to bonding to treatment with continous, not-perforating electric discharge, and prepared from a block crystalline ethylene-propylene copolymer having an ethylene content of 2.5% and a melt index of 12. The sheet had the following characteristics:

thickness	52 microns
transmittance	1 %
permeability:	
to oxygen	30 $cm^3/m^2.24$ h.kg/cm^2
to carbon dioxide	140 $cm^3/m^2.24$ h/kg/cm^2
to water vapour	1.5 $g/m^2.24$ h
weldability range	135-155°C
resistance of the weld	650 g/cm
resistance to perforation	1300 g

Example 3

A bonded sheet was prepared as in Example 1, except that film B was replaced by an unoriented, 25 micron thick film, subjected prior to bonding to treatment with continuous, not-perforating electric discharge, and prepared from a mixture comprising 90% of polypropylene having a melt index of 10, a residue after extraction with heptane of 96.5%, and an ash content of 75 ppm, and 10% of low-density polyethylene. The sheet has the following characteristics:

thickness	52 microns
transmittance	1 %
permeability:	
to oxygen	35 $cm^3/m^2.24$ h.kg/cm^2
to carbon dioxide	140 $cm^3/m^2.24$ h.kg/cm^2
to water vapour	1.5 g/m^2 . 24 h
weldability range	135-155°C
resistance of the weld	600 g/cm
resistance to perforation	1300 g

Example 4

A bonded sheet was prepared as in Example 1, except that film B was replaced by an unoriented, 25-micron thick film subjected prior to bonding to treatment with continuous, not-perforating electric discharge, and prepared from a mixture comprising 5% of polyethylene having a melt index of 2, and 95% of a random crystalline ethylene-propylene copolymer containing 2% of ethylene and having a melt index equal to 10. The sheet had the following characteristics:

thickness	52 microns
transmittance	1 %
pemeability:	
to oxygen	40 $cm^3/m^2.24$ h.kg/cm^2
to carbon dioxide	140 $cm^3/m^2.24$ h.kg/cm^2
to water vapour	2 $g/m^2.24$ h
weldability range	130-150°C
resistance of the weld	600 g/cm
resistance to perforation	1200 g

Example 5

A bonded sheet was prepared as in Example 1, except that the bonding rollers were heated to 30°C instead of to 70°C and that film B was replaced by an unoriented, 25-micron thick film, subjected prior to bonding to a treatment with continuous, not-perforating electric discharge, prepared from a low-density polyethylene having a melt index of 2. The sheet had the following characteristics:

thickness	52 microns
transmittance	1 %
permeability:	
to oxygen	50 $cm^3/m^2.24$ h.kg/cm^2
to carbon dioxide	150 $cm^3/m^2.24$ h.kg/cm^2
to water vapour	2 $g/m^2.24$ h
weldability range	115-125°C
resistance of the weld	600 g/cm
resistance to perforation	1200 g

Example 6

A bonded sheet was prepared as in Example 1, except that film B was replaced by a polypropylene film, bioriented by stretching longitudinally and transversely, 25 microns thick, prepared from polypropylene having a melt index of 4, coated on the side remote from the film A with a welding layer applied without any prime by extrusion coating. The welding layer consisted of a random crystalline ethylene-propylene copolymer containing 5% of ethylene, having a melt index of 10. Prior to bonding, film B was subjected to treatment with continuous, not-perforating electric discharge. The bonded sheet had the following characteristics:

thickness	52 microns
transmittance	1 %
permeability:	
to oxygen	20 $cm^3/m^2.24$ h.kg/cm^2
to carbon dioxide	130 cm^3/m^2 −24 h.kg/cm^2
to water vapour	1 g/m^2. 24 h
weldability range	135-155°C
resistance of the weld	400 g/cm
resistance to perforation	1500 g

Example 7

A bonded sheet was prepared as in Example 6, except that the welding layer coated film B was replaced by a mixture comprising 95% of polypropylene having a melt index of 12, a residue after extraction with heptane of 96.5%, an ash content of 75 ppm, and 5% of low-density polyethylene. The resulting bonded sheet had the following characteristics:

thickness	52 microns
transmittance	1 %
permeability:	
to oxygen	25 $cm^3/m^2.24$ h.kg/cm^2
to carbon dioxide	130 $cm^3/m^2.24$ h.kg/cm^2
to water vapour	1 $g/m^2.24$ h
weldability range	135-155°C
resistance of the weld	400 g/cm
resistance to perforation	1500 g

Example 8

A bonded sheet was prepared as in Example 6, except that the welding layer coating film B was replaced by a mixture comprising 5% of low-density polyethylene having a melt index of 5, and 95% of a random crystalline ethylene-propylene copolymer containing 2% of ethylene and having a melt index of 10. The resulting bonded sheet had the following characteristics:

thickness	52 microns
transmittance	1 %
permeability:	
to oxygen	30 cm^3/m^2. 24 h.kg/cm^2
to carbon dioxide	140 cm^3/m^2.24 h.kg/cm^2
to water vapour	1 g/m^2.24 h
weldability range	130-150°C
resistance of the weld	450 g/cm
resistance to perforation	1400 g

Example 9

A bonded sheet was prepared as in Example 1, except that film B was replaced by a film oriented by stretching longitudinally and transversely, of 25-microns thickness, prepared from polypropylene having a melt index of 3, a residue after extraction with heptane of 96%, an ash content of 80 ppm, treated with continuous, not-perforating electric discharge, the face of the film remote from the film A being coated with a vinyl lacquer made from a solution of a vinyl chloride/vinyl acetate (87/13) copolymer in methyl ethyl ketone, after coating with polyethylene imine. The bonded sheet had the following characteristics:

thickness	54 microns
transmittance	1 %
permeability:	
to oxygen	25 cm^3/m^2.24 h.kg/cm^2
to carbon dioxide	130 cm^3/m^2.24 h.kg/cm^2
to water vapour	1.5 g/m^2.24 h
weldability range	120-140°C
resistance of the weld	450 g/cm
resistance to perforation	1500 g

Example 10

A bonded sheet was prepared by conveying between rollers heated to 90°C:

A a polypropylene film bioriented by stretching longitudinally and transversely, subjected prior to bonding to continuous, not-perforating electric discharge, metallized under vacuum with aluminium (surface resistivity = 3 Ohm), having the following characteristics:

thickness	25 microns
longitudinal tensile strength	13 kg/mm^2
transverse tensile strength	28 kg/mm^2
longitudinal elongation	180 %
transverse elongation	45 %
resistance to tearing (Elmendorf)	11 g/25 microns

The polypropylene employed was a polymer having prevailingly isotactic macromolecules, prepared using a stereospecific catalyst, having a melt index of 4, a residue after extraction with heptane equal to 96.5% and an ash content of 75 ppm. The film was coated, on its metallized face, with a polyurethane-based adhesive in an amount of 1.5 g/m^2 of surface and that face was contacted with:

B a 30-micron thick unoriented film, prepared from a mixture comprising 90% of polypropylene having a melt index of 10, a residue after extraction with heptane of 96.5%, and an ash content of 75 ppm, and 10% of low-density polyethylene. The resulting bonded sheet had the following characteristics:

thickness	55 microns
transmittance	1 %
permeability:	
to oxygen	35 cm^3/m^2 . 24 h.kg/cm^2
to carbon dioxide	140 cm^3/m^2.24 h.kg/cm^2
to water vapour	1.5 g/m^2. 24 h
weldability range:	135-155°C
resistance of the weld	600 g/cm
resistance to perforation	1300 g

Example 11

By passage between rollers heated to 70°C. a bonded sheet was prepared from:

A a polypropylene film bioriented by stretching longitudinally and transversely, that was treated prior to bonding with continuous, not-perforating electric discharge, and had the following characteristics:

thickness	25 microns
longitudinal tensile strength	13 kg/mm^2
transverse tensile strength	28 kg/mm^2
longitudinal elongation	180 %
transverse elongation	45 %
resistance to tearing (Elmendorf)	11 g/25 microns.

The polypropylene utilized was a polymer having predominantly isotactic macromolecules, prepared using a stereospecific catalyst, having a melt index of 4, a residue after extraction with heptane of 96.5%, and an ash content of 75 ppm. One face of the film was coated with a polyurethane-based adhesive at a rate of 1.5 g/m^2 of surface and contacted with:

B a polypropylene film bioriented by stretching longitudinally and transversely, 25 microns thick, prepared from polypropylene having a melt index 4, having its face to be remote from the film A coated with a welding layer (2 microns thick) applied without any primer by co-extrusion. The welding layer consisted of a block crystalline ethylene-propylene copolymer containing 5% of ethylene, and having a melt index of 10. Prior to bonding, the other face of film B to be contacted with the film A was treated with continuous, not-perforating electric discharge and subsequently metallized under vacuum with aluminium (surface resistivity = 3 Ohm). The bonded sheet had the following characteristics:

thickness	54 microns
transmittance	1 %
permeability:	
to oxygen	20 cm^3/m^2 .24 h.kg/cm^2
to carbon dioxide	130 cm^3/m^2.24 h.kg/cm^2
to water vapour	1 g/m^2.24 h
weldability range	135-155°C
resistance of the weld	400 g/cm
resistance to perforation	1500 g

Example 12

A bonded sheet was prepared as in Example 11, except that the welding layer of film B was replaced by a mixture comprising 95% of polypropylene having a melt index of 12, a residue after extraction with heptane of 96%, an ash content = 80 ppm, and 5% of low-density polyethylene. The bonded sheet had the following characteristics:

thickness	54 microns
transmittance	1 %
permeability:	
to oxygen	25 cm^3/m^2.24 h.kg/cm^2
to carbon dioxide	130 cm^3/m^2.24 h.kg/cm^2
to water vapour	1 g/m^2.24 h
weldability range	135-155°C
resistance to welding	400 g/cm
resistance to perforation	1500 g

Example 13

A bonded sheet was prepared as in Example 11, except that the welding layer of film B was replaced by a mixture consisting of 5% of polyethylene having a melt index of 5, and 95% of a random crystalline ethylene-propylene copolymer containing 2% of ethylene and having a melt index of 10. The resulting bonded sheet had the following characteristics:

thickness	54 microns
transmittance	1%
permeability:	
to oxygen	30 cm^3/m^2.24 h.kg/cm^2
to carbon dioxide	140 cm^3/m^2.24 h.kg/cm^2
to water vapour	1 g/m^2. 24 h
weldability range	130-150°C
resistance of the weld	450 g/cm
resistance to perforation	1400 g

Example 14

A bonded sheet was prepared as in Example 11, except that film B was replaced by a film oriented by stretching longitudinally and transversely 25 microns thick, prepared from polypropylene having a melt index of 3, a residue after extraction with heptane of 96%, an ash content of 80 ppm, treated with a continuous, not-perforating electric discharge; the face of the film remote from the film A being coated with a vinyl lacquer made of a solution of a vinyl chloride/vinyl acetate (87/13) copolymer in methyl ethyl ketone, after coating with polyethylene imine, and the other face to be contacted with the film A being coated, by metallization under vacuum, with an aluminium layer having a surface resistivity of 3 Ohm. The resulting bonded sheet had the following characteristics:

thickness	54 microns
transmittance	1%
permeability:	
to oxygen	25 $cm^3/m^2.24$ h.kg/cm^2
to carbon dioxide	130 $cm^3/m^2.24$ h.kg/cm^2
to water vapour	1.5 $g/m^2.24$ h
weldability range	120-140°C
resistance of the weld	450 g/cm
resistance to perforation	1500 g

WHAT WE CLAIM IS:

1. A bonded sheet for packing comprising A a film oriented by stretching of polypropylene consisting essentially of isotactic macromolecules, having a melt index of from 0.5 to 5, and B a film, prepared from polyethylene, isotactic polypropylene, a propylene-ethylene crystalline copolymer containing predominantly propylene of the block or the random type, a mixture of polyethylene with polypropylene or with a propylene-ethylene copolymer or a mixture of polypropylene with a propylene-ethylene copolymer, at least one of the two films having on its surface in contact with the other film a metallized layer with a resistivity of from 1 to 5 Ohm.
2. A bonded sheet according to claim 1 in which the film B comprises a polyethylene having a melt index of from 0.5 to 15, a polypropylene having a melt index of from 5 to 20, or a crystalline ethylene-propylene copolymer having a melt index of from 3 to 20.
3. A bonded sheet according to claim 1 or claim 2 in which the metallized layer consists of aluminium.
4. A bonded sheet according to any preceding claim in which at least one of the two films is coated on the side remote from the other film with a thermowelding layer.
5. A bonded sheet according to any preceding claim in which an adhesive is interposed between the films.
6. A bonded sheet as herein described in any of the Examples.

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